DOUGHTY

Comparisons of the Costs of Coal Mining in Vermilion County, Ill.

Civil Engineering

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COMPARISONS

OF THE

COSTS OF COAL MINING

IN

VERMILION COUNTY, ILL.

BY

IVAN FREMONT DOUGHTY

THESIS

FOR

DEGREE OF BACHELOR OF SCIENCE

IN

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This is to certify that the thesis prepared under the immediate direction of Instructor L. G. Parker by

IVAN FREMONT DOUGHTY

entitled COMPARISONS OF THE COST OF COAL MINING IN VERMILION COUNTY, ILLINOIS

is approved by me as fulfilling this part of the requirements for the Degree of Bachelor of Science in Civil Engineering.

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Head of Department of Civil Engineering

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INTRODUCTION.

In this thesis it is proposed to discuss the different items of expense in the production of coal in some of the mines of Vermilion County, Illinois. The data in the appended tables was compiled by the writer partly from the answers recieved from fifty circular letters and partly from semi-private cost-sheets. Several of the large mines, and some of the smaller ones, refused to give any information whatever, but the results given are fairly trustworthy. The writer has chosen this thesis subject because of his personal familiarity with the characteristics and equipment of the larger mines, and because of the lack of available data on the subject.

Geographically, the area treated in this thesis lies between Lats. 39°50' and 40°30' North, and between 87°35' and 87°55' West Longitude. It includes all of Ver-

milion County, Illinois, and includes the greater part of the Danville quadrangle of the United States Geological Survey.

The coal strata are well defined, and on account of numerous borings that have been made, the thickness and other physical characteristics of the coal seams have been accurately determined. Numerous outcroppings of coal due to erosion by the Vermilion River, gave first evidence that the mineral was present. This river has had a marked effect on the topographical and mineralogical features in its vicinity. Preglacial erosion removed practically all the coal northeast of the City of Danville, and in more recent geologic times this same agent has laid bare and removed a noticeable amount of the remaining portions.

Borings and numerous shafts show that the main body of coal is to be found in two nearly horizontal seams. The more shallow of these strata, which varies in thickness from zero to six feet, is local-

-ly known as the Danville Seam. It is gener-
-ally found overlaid by beds of soft shale
or earth, at depths below the surface vary-
ing from zero to seventy-five feet. Beneath
this coal stratum is a varying deposit
of fire-clay, shale, and in some places
sandstone, giving an aggregate thick-
ness of from twenty-five to seventy feet.
This is followed by the second and most
valuable of the coal strata, known as the
Grape Creek Seam. This deposit ranges
in thickness from two to nine feet, six
and one-half feet being a fair average.

The Grape Creek Seam is underlaid by
a succession of irregular beds of fire-clay,
shale, slate, and sandstone for an ad-
-ditional depth of from two hundred to
two hundred and fifty feet, at which
level we reach the third or Big Muddy
Seam. It has a fairly uniform thick-
ness of five feet, but the coal is of doubt-
ful utility on account of considerable
quantities of foreign matter interspers-
ed through the mass.

Although the Danville and Grape Creek seams are found in approximately parallel superimposed strata, it has been found that where one seam is workable, the other is either too thin or else is so mixed with impurities as to render its mining an uncertain and unprofitable undertaking. Hence the mines in any particular locality, work only the most favorable seam at that place, and neglect the other coal bed entirely. The workable area of the Danville Seam is found within a radius of two or three miles from Danville, and mostly to the south and west of it. Although there are several large mines in this area, the largest producing mines in the county, are found working in the Grape Creek seam, at distances varying from four to eight miles south of Danville.

The following table shows the chemical composition, and the number of British Thermal Units per pound in coals from the Danville and Grape Creek seams,

and for the sake of comparison the same data is given for the Pocahontas variety of West Virginia steam coal.

COMPARISON OF DANVILLE COALS WITH A SEMI-BIT. COAL.

TABLE I.

LOCALITY OR SEAM	ASH	MOISTURE	WATER OF COMPOSITION	TOTAL VOLATILE COMBUSTIBLE	TOTAL CARBON	TOTAL SULPHUR	B. T. U.
DANVILLE SEAM	5.65	8.28	12.55	30.41	66.94	2.88	12589
GRAPE CREEK SEAM	5.83	11.20	15.55	20.31	64.74	0.83	11824
POCA-HONTAS SEAM	3.49	0.93	4.21	14.50	76.88		
	PER CENT	PER CENT	PER CENT	PER CENT	PER CENT	PER CENT	

The analyses for the above table were all made under the supervision of Dr. S. W. Parr, Professor of Applied Chemistry at the University of Illinois, and the results were taken from his pamphlet entitled "Coals of Illinois, Their Composition and Analysis." The coals shown in the above table from the Danville and Grape Creek seams, were typical samples of those varieties. The well known Poca-

-hontas coal from West Virginia is a standard steam coal.

By reference to the above table, we may derive the following conclusions: (1) The Danville and Grape Creek coals with similar percentages of ash, ~~are~~ have nearly twice as much ash as the Pocahontas coal. (2) We have the rather surprising result that the Grape Creek coal contains considerably more moisture than the Danville coal, although secured at a greater depth. The Pocahontas coal almost a complete lack of moisture, due to the great pressure and subsequent heating to which all coals from this vicinity have been subjected by nature. (3) In the item of ratio of composition the Danville and Grape Creek coals show respectively about three and four times as much as the Eastern coal. (4) As would be expected, the Danville coal being the softest of the three, has the greatest percent of 'total volatile matter', and the Pocahontas coal has the least. (5) The latter coal exceeds the

two former in total carbon by about ten per cent. (6) The Danville coal contains more than three times as much sulphur as either of the others.

These differences then, furnish the key to the variations in the burning qualities of the different coals. The coal from the Danville seam with its high percentage of volatile combustible, is soft, easy of ignition and burns quite rapidly with a yellow flame and considerable smoke. This variety is unsuited for ore smelting on account of the large sulphur content. For a domestic coal however, this variety is fairly satisfactory.

In general the coal of the Grape Creek seam is purer than the Danville variety, containing hardly any of the objectionable sulphur rock. On account of the lower percentage of volatile combustible matter, Grape Creek coal burns slower and with less smoke than the Danville coal. It is a good stove and steam coal, and on account of its cheapness,

it is used very extensively by the Illinois Steel Company. Both the Danville and Grape Creek coals are inferior to the Pocahontas coal, which has less water, ash and volatile matter, and a greater amount of carbon, thus making it a harder, slower burning and less smoky coal.

GENERAL DESCRIPTION OF MINES.

On account of the great differences in the methods of handling coal, the mines of the county are here classified under two heads, namely "Shipping Mines" and "Local Mines."

Shipping Mines.

With but two or three exceptions all the more important of the shipping mines are located in Georgetown, Catlin and Danville townships, and the majority of them are working in the Grape Creek seam, four to eight miles south of Danville.

In the following table (II) the different items in the cost are taken directly from an actual monthly cost sheet for the six Kelly mines, the other seven large mines refusing to furnish any specific information

MONTHLY COST SHEET FOR KELLY MINES - FEB. 05.

TABLE II.

MINE	HRS. WORK	TONNAGE TONS	COST OF DIGGING $		HAULAGE $		OTHER INSIDE LABOR $		PREPARING AND SHIPPING $		OTHER OUTSIDE LABOR $		SUPT. AND CLERK $		TOTAL LABOR $	SUP-PLIES $	TOTAL L+M. COST $
			TOTAL	P.T.	TOTAL	P.T.	TOTAL	P.T.	TOTAL	P.T.	TOTAL	P.T.	TOTAL	P.T.	PER TON	PER TON	PER TON
KELLY'S #2	162	25252.+	13695.11	.55	2098.08	.083	3387.71	.134	84.46	.003	1015.53	.041	200.00	.008	.269	.036	.858
KELLY'S #3	151	26584.+	14920.08	.56	1320.25	.049	4140.76	.156	228.65	.009	1022.07	.038	237.50	.009	.261	.067	.887
KELLY'S #4	129	24258.+	13299.68	.55	1190.14	.049	2903.60	.119	219.99	.009	618.73	.025	192.50	.008	.210	.045	.803
KELLY'S #5	134	18458.+	10376.86	.56	721.22	.039	2602.60	.141	170.89	.009	448.26	.024	180.00	.010	.223	.031	.817
AIMROD	156½	27186.+	14601.80	.54	1787.47	.066	4091.85	.150	223.71	.008	1304.94	.048	200.00	.008	.280	.084	.901
PAWNEE	131½	20990.+	11543.19	.55	1863.71	.088	3727.92	.180	209.67	.010	880.69	.042	180.00	.009	.329	.061	.940
TOTALS + AVERAGES		142730.+	78706.+	.55	8975.87	.063	20854.42	.147	1137.37	.008	5290.22	.037	1190.00	.008	.263	.056	.870

NOTE.— This table does not include depreciation, taxes or mineral rights or cost of equipment.

DISCUSSION OF TABLE TWO.

The six mines in the list are among the largest producers in the state. It will be seen that the cost per ton in this group (exclusive of mineral rights, cost of equipment, taxes and depreciation) varies from $.803 to $.940. These values are influenced by the age of the mine (being less in new mines) and the kind of haulage in use. Beginning with least expensive or most economical mine, we have the five year old Kelly's No. Four, which has a modern equipment but no mechanical haulage underground. The No. Five mine is still newer, but the cost here is increased by the fact that from ten to fifteen inches of draw slate falls after the removal of the coal, and this must be removed at additional expense.

The cost of hauling coal underground by means of mules, increases steadily with the length of the haul. The usual load for one mule on favorable grades, is four loaded cars containing from two to four thousand

pounds of coal each. When the length of haul exceeds two or three thousand feet, mechanical haulage is generally resorted to, as supplementary to the mule haulage. The Pawnee mine has a tailrope haulage system over six thousand feet in length, while in mines No. Two and Himrod, the electric haulage system has been in use for some time. In Kelly's No. Three mine, we have an example of long underground hauls without mechanical aid. On account of favorable grades it is possible to haul the coal in trains of ten or twelve cars each, using two or three mules on train for this purpose. In this particular case, the cost per ton is not excessive.

The Himrod mine excels all the others in perfection of mechanical equipment, and facilities for treating and handling the coal. Some of these features are: steel tipple, three tons cars, washers, shaker screens, storage bins, twelve ton gravity motors, compressed air drills etc.

The Pawnee and Himrod mines, both

have considerable quantities of water to handle. All the coal is washed at the Pawnee mines, and nearly all the mining is done on one side of the mine, due to the propinity of old water-filled workings on the other side. The Pawnee and Himrod mines are occasionally choked in places by inrushes of quicksand, and the cost of mining is increased a both places by numerous horsebacks.

Discussion of the Items of Table II.

Cost of Mining.— By reference to table II, it will be seen, that the cost per ton of digging coal is about the same for nearly all the large shipping mines and averages about fifty-five cents per ton. This item is fixed by the scale of wages in force in this district.

Cost of Inside Labor. The items under the heading of "other inside labor" include all additional underground labor expenses exclusive of haulage. On examination it will be seen that mine No. Four has the

cost for this item, with twelve cents per ton. The next in point of cheapness is Mine No. Two, the oldest of the group. Then come No. Five, Kinrod, No. Three and Pawnee in the order named. It seems difficult to account for some of these apparent discrepancies. Generally speaking, "other inside labor" includes the force of night men employed at the large mines. The price of coal is greatly affected by the purity and continuity of the coal seam. Hence we find that in the three higher priced mines that numerous intruding seams of rock are encountered. These foreign masses occasionally run for hundreds of feet in the direction of the coal entry, and must be tunneled through entirely as dead work.

In general the force of men employed in caging the coal at the bottom of the shaft is fairly uniform for mines of similar capacity.

Mine No. Three has an advantage over all the others in that no water must

be handled. At Hiawood and Pawnee however enough water is encountered to run washers, and to handle this large quantity large pumps are in continuous operation. The per ton price of inside labor at the Pawnee mine is much the highest of the group. This is probably due to excess of water, insufficient drainage and consequent bad roads and the resultant diminution of the load per mule.

Preparing and Shipping.- Preparing and shipping does not include freight charges, but only the loading in flats, weighing and other incidental treatment such as washing and picking out rock. Mine No. Two for instance is much less than Pawnee in this respect, because the latter mine washes all the coal. In any of the cases this item does not exceed one cent per ton, so it will not be considered further.

Other Outside Labor.- This item includes all surface employees, such as engineers, firemen, trackmen etc, and

all other work done above the surface. Here again we find that the expenses are only about one-half as much in the newer mines as they are in the older ones. This is probably due to the fact that all the equipment at the new mines is in good working condition and on that account entails but little delay and repair. With the installation of dynamos air compressors etc. at the older mines, and the increasing number of repairs needed for the older equipment, the per ton price has naturally increased in these places. Hainrod and Pawnee mines are the most expensive mines under this heading, due to the amount of equipment at those places.

Supt. and Clerk.- There is a superintendent at each mine, and also a clerk at some of the mines, but the additional cost per ton due to this item is very small, and is comparatively uniform, so will be further considered.

Supplies.— The item of supplies gives per ton expenses varying from a trifle over three cents at No. Hibe up to a maximum of 8.4 cents per ton at Hunnord mine. This follows logically enough, since the older and more extensive mines naturally require more supplies, and the production does not increase proportionally to with the area of the mine, since all the working places are grouped near the end of each entry.

According to the table, the total cost for labor, exclusive of digging, amounts to practically one-half the cost of digging.

The companies do not give out information concerning taxes, interest or depreciation, but in regard to depreciation it may be stated that a mine may be profitably worked for from fifteen to eighteen years with only ordinary repairs.

LOCAL MINES

For the purpose of comparing expenses in the smaller or local mines with expenses in the large shipping mines, fifty circulars were sent out including ~~some of~~ the following questions: (1) Average monthly output, (2) Average selling price per ton, (3) tons of coal used at the plant, (4) Average thickness of the seam, (5) Average number of kegs of powder per month, (6) Average number of miners, (7) average price per ton for mining, (8) average number of working days per month, (9) average total monthly wages of day men, (10) total monthly pay-roll, (11) total monthly timber expenses, (12) total monthly expense of all other dead work, (13) average monthly feed bill, (14) average monthly incidental expenses, (15) estimated cost of plant, (16) estimated annual cost of repairs, (17) taxes per year, (18) cost of mineral rights per acre or (19) cost of royalty per bushel. In response to these circulars, there were received seven full reports, eight partial reports

and answers were received from five operators, who for various reasons refused to give any information whatever. The results from these circulars have been tabulated, and are presented below on page 20, in table III.

COST SHEET FOR ONE MONTA-LOCAL MINES.

TABLE III.

NAME	OUTPUT	COST OF DIGGING $		OTHER LABOR $		TIMBERING $		INCIDENTALS $		INTEREST $		REPAIRS $		TAXES MIN. RT. OR ROYALTY $		TOTAL $
	TONS	580.00	P.T.	TOTAL	P.T.	TOTAL	P.T.	TOTAL	P.T.	TOTAL	P.T.	TOTAL	P.T.	TOTAL	P.T.	P.T.
D.D. MORIN	1000	208.00	.58	109.20	.109	36.00	.036	4.00	.004	12.50	.012	12.50	.012	38.00	.038	.791
CARTER BROS.	400	60.00	.52	192.00	.48	30.00	.075	20.00	.050	8.00	.020	10.00	.025	46.00	.115	1.28
H. HARRIS	100	390.00	.60	40.00	.40	8.00	.080	5.00	.05	2.00	.020	3.50	.035	——	—	1.18
FRANCE BROS	600	662.00	.65	144.00	.24	8.00	.014	4.00	.007	10.00	.018	17.00	.028	36.80	.062	1.02
MAUCK BROS.	1140		.58	236.00	.207	11.00	.010	27.00	.024	12.00	.011	8.50	.008	12.00	.011	0.85
JOE MAUCK	460	240.00	.52	64.00	.139	5.00	.011	15.00	.033	17.50	.038	4.25	.009	9.00	.020	0.77
MAUCK #1.	1500	900.00	.60	850.00	.57	6.00	.004	55.00	.037	12.50	.008	20.00	.013	10.70	.007	1.24
AVERAGES	742.8		.58		.314		.020		.025		.014		.014		.033	1.00

DISCUSSION OF TABLE III.

Taking the items in table III in order from left to right we have first:

Monthly output.- The amount of coal mined per month in these mines is very small, varying from one hundred to fifteen hundred tons, with an average of seven hundred forty three.

Cost of Digging.- There are two prices per ton being paid for mining coal, as follows: room coal fifty two cents per ton and entry or narrow width coal, seventy five cents per ton. On account of the greater quantity of room coal mined (due to greater width of the working face) the average price per ton is about fifty eight and one-half cents.

Other Labor.- The item of other labor, embraces all internal and external labor except timbering and repairs. The cost of this item varies between a minimum of eleven cents and a maximum of fifty seven cents per ton. Where the output is very low (as in the present case)

the addition of even one man to the force causes a material increase in the per ton labor item. Suppose we take the average of those mines with an output of thirty tons per day, and assume that labor there costs twenty-four cents a ton. Now add one employee at $2.40 per day, to the force, then the additional per ton cost of labor due to this addition will be 2.40 ÷ 30 or 8 cents. Hence in some cases great apparent discrepancies in the table may be accounted for by the fact that the owners work personally in some of the mines, and have not charged up their own time, while others do charge it up to the general cost. The smaller mines are generally scantily supplied with equipment, hence but little of the cost of labor can be ascribed to this.

Timbering.- By reference to the above table, it will be observed that the cost of timbering varies from 0.4 cents to 8.0 cents a ton. This difference may be accounted for in different ways. (1) The condition

of the roof varies in the different mines. A hard roof needs scarcely any timbering while on the other hand a soft shale roof falls freely and must be extensively timbered. (2) Some of the mines are so located that the miners can cut all necessary timber from the surrounding forest, at a considerable saving in shipping and haulage. (3) Mine owners differ in the method of timbering employed. Those who provide for a considerable time ahead by plentiful timbering, must necessarily pay the difference between this and poor timbering and charge it to the cost of production. It is well to observe that timbers are used but once.

Incidentals.— Under this heading are grouped such items as care of mules, harness, and all other unclassified expenses. This item varies in the different mines from 0.4 cents to 5.0 cents per ton, with an average of 2.5 cents.

Interest.— Interest on the investment is included in the table. In figuring the

interest the amount of interest at 5% was computed on the capital value of the plant as reported by the owner, and is found to average about two cents a ton.

Repairs.- The item depreciation is included under repairs, and the cost of this item varies from 0.8 to 3.5 cents per ton, being less in the larger mines. This seems to show that the additional cost for equipment in the larger mines is more than counterbalanced by the resultant increase in output.

Summing up the total costs for the local and shipping mines, we find that even the most expensive of the shipping mines has a smaller per ton cost for labor and materials than the average local mine. The average price for the larger mines is about twelve cents lower per ton than that for the local mines. Hence the coal from the smaller mines must be sold at a higher unit price than the coal from the large producers.

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